PHYSIOLOGY

Qualitative Difference between Male and Female Erythrocytes

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 128, No. 10, pp. 372-374, October, 1999
Original article submitted April 27, 1999

Erythrocytes in men and women were characterized by similar distribution of cell volumes and their mean values, but considerably differed in the correlations of volumetric parameters with cell count, hematocrit, and hemoglobin content. The factorial structure of the correlations showed sex-related specificity. These data suggest that male and female erythrocytes are qualitatively different.

Key Words: *erythrocytes; functional characteristics; volume; correlation; sex-related specificity*

Characteristics of human blood erythrocytes are known to be sex-specific. Men and women differ in their erythrocyte concentration, hemoglobin (Hb) content, cell size [4], some biochemical indices [2], and electrophoretic mobility [5]. Given the fact that erythrocyte population is heterogenous and consists of cells with different properties, it remains unclear whether the difference in average indices can be explained by qualitative specificity of male and female erythrocytes or just by a different subpopulation structure. The problem of the sex-related specificity of erythrocytes has never been considered in this way, and this work was designed to analyze it by studying the correlations between the main functional characteristics of these cells in men and women.

MATERIALS AND METHODS

Blood samples from healthy men (n=14) and women (n=24) aged 35-50 years were analyzed with a Sysmex NE-1500 analyzer. The following parameters were determined: erythrocyte count, Hb, hematocrit, mean Hb content per erythrocyte, mean erythrocyte volume. Standard deviation, coefficients of variation, asymmetry (As), and excess (Ex) were calculated from the volume distribution histograms. Student's t test was used to evaluate the difference between the mean values. Correlation analysis was performed using "Statistica" software.

RESULTS

The first three indices showed distinct differences between male and female erythrocyte populations (Table 1): erythrocyte count, Hb, and hematocrit were significantly higher in men, which agrees with published data. Other indices differed insignificantly. The erythrocyte volume distribution analysis revealed positive asymmetry (peaks are shifted towards low values) and a strong positive excess which implies a high homogeneity of cell population. Erythrocyte volume distribution was generally similar to cell area distribution [4].

We found no sex-related differences in the mean erythrocyte volume, which is inconsistent with some published data indicating that male and female erythrocytes significantly differ in size [4]. This discrepancy can probably be explained by different technical approaches: in the cited study cell size was determined by its area. Because of a biconcave shape of erythro-

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0007-4888/99/0010-0978$22.00

cytes, evaluation of the cell size by area and by volume is not the same, the more so as a Sysmex NE-1500 analyzer of class III makes a correction for volume [7]. Furthermore, the volumetric approach is more adequate, since Hb content and concentration are also calculated per cell volume [3].

The analysis of correlations between the studied parameters showed that despite similar mean volumes of male and female erythrocytes, the structure of correlations between distribution parameters and other indices in men and women differed significantly (Table 2). This difference was manifested even in the number of significant correlations: 14 in men and 10 in women despite a higher threshold of statistical significance applied in the analysis of male population. Both groups showed similar positive correlations between hematocrit, Hb, and erythrocyte count, as well as between Hb and the erythrocyte concentrations. Being of no special interest by themselves, these obvious correlations confirm the reliability of other interrelations.

It is noteworthy that standard deviation of erythrocyte volume in men closely correlated with Hb, hematocrit, erythrocyte count, and volume variation coefficient, while no such correlations were observed in women. In men, the excess of cell volume distribution was proportional to Hb concentration, while erythrocyte volume variations depended on nonvolumetric parameters, being directly related to Hb content, hematocrit, and erythrocyte count. The difference between male and female erythrocyte populations was confirmed by the correlation matrix factor analysis showing that their covariations were described by different number of variables and these factors had different structures.

These data indicate that despite similar mean volumes and volume distributions of erythrocyte populations in men and women, such a basic cell characteristic as cell volume is regulated in a sex-specific way at the systemic and/or cellular level [1,4,6]. Male and

TABLE 1. Indices of Red Blood in Men and Women ($M \pm m$)

Index		Men (n=14)	Women (n=24)
Erythrocytes, 10^{12}/liter		4.4±0.1	3.9±0.1*
Hemoglobin, g/liter		133.1±3.0	121.5±2.8*
Hematocrit, %		36.9±0.8	33.6±0.7*
Mean hemoglobin content per erythrocyte, pg		30.2±0.5	30.4±0.4
Mean erythrocyte volume, fl		89.0±1.4	87.7±1.5
Parameters of erythrocyte volume distribution	SD	22.0±0.5	20.7±0.5
	As	1.9±0.05	1.80±0.08
	Ex	5.1±0.23	5.50±0.27

Note. Data are expressed as means and standard errors; *p<0.05 in comparison with the corresponding value in men.

TABLE 2. Correlation Matrix for Erythrocyte Parameters

Subjects	Indices	Correlation coefficients, $\times 10^{-1}$								
Men	Hemoglobin	1								
	Cell hemoglobin	33	2							
	Hematocrit	97*	15	3						
	Erythrocytes	83*	-20	92*	4					
	Volume	43	18	34	29	5				
	SD	64*	-18	68*	84*	22	6			
	As	-08	46	-16	-38	-07	-45	7		
	Ex	-12	62*	-22	-47	-27	-43	93*	8	
	Amplitude	68*	-02	70*	79*	13	88*	-67*	-55*	9
Women	Hemoglobin	1								
	Cell hemoglobin	62*	2							
	Hematocrit	93*	35	3						
	Erythrocytes	79*	01	91*	4					
	Volume	35	40*	34	13	5				
	SD	14	16	09	07	15	6			
	*As	-05	-24	-04	09	-15	59*	7		
	Ex	-14	-13	-15	-01	-09	49*	83*	8	
	Amplitude	03	-11	14	12	26	-14	-46*	-56*	9

Note. *significant correlation (p<0.05).

female erythrocytes seem to be qualitatively different. Volume variations directly correlate with standard deviation in men, but not in female population, where the proportion of small cells and the homogeneity of their subpopulation increase with increasing standard deviation. It can be suggested that the hormonal status of the individual significantly contribute to the revealed differences [2,8].

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